

Claims

What is claimed:

1. An apparatus for maintaining a data circuit in the event that one or more devices within the data circuit become inoperable, the apparatus comprising:

a plurality of interface cards for transmitting and receiving data streams;

a cross-connect unit for routing the data streams received from a first set of said plurality of interface cards to a second set of said plurality of interface cards, said cross-connect unit routing each data stream based on an associated matrix, wherein the associated matrix identifies the interface cards that will receive the data stream and an order that the interface cards will receive the data stream;

a control unit for controlling the operation of the apparatus; and

a backplane forming connections between the cross-connect unit and each of the plurality of interface cards.

2. The apparatus of claim 1, wherein the associated matrix includes a source point and a destination point for each section of the data circuit, wherein a section is defined as a transmission of the data stream from one interface card to another interface card, the source point corresponds to a

transmitting interface card and the destination point corresponds to a receiving interface card.

3. The apparatus of claim 2, wherein the associated matrix further includes a next drop point for each destination point so that said cross-connect unit can route the data stream to the next drop point if the receiving interface card associated with the destination point is inoperable.

4. The apparatus of claim 3, wherein in the event that consecutive interface cards are inoperable said cross-connect unit can continually utilize the next drop point in the associated matrix to determine the next interface card to receive the data stream.

5. The apparatus of claim 2, wherein the associated matrix further includes a previous point for each source point.

6. The apparatus of claim 5, wherein the previous point is used to incorporate an interface card that is defined as part of the data circuit and that was previously inoperable back into the data circuit when the interface card becomes operational.

7. The apparatus of claim 1, wherein each of said plurality of interface cards is connected to all other of said plurality of interface cards through said cross connect unit.

5 8. The apparatus of claim 1, wherein the apparatus is an Ethernet switch.

9. The apparatus of claim 1, wherein the apparatus is an add-drop multiplexer.

10 10. The apparatus of claim 1, wherein said plurality of interface cards include telecommunication cards.

11. The apparatus of claim 10, wherein said
15 telecommunication cards include Wavelength Division Multiplexed (WDM) and Time Division Multiplexed (TDM) cards.

12. The apparatus of claim 10, wherein the telecommunication cards include SONET, SDH and PDH cards.

20 13. The apparatus of claim 1, wherein said plurality of interface cards include a SONET card.

14. The apparatus of claim 13, wherein said data cards
25 include Ethernet, Token Ring and FDDI cards.

15. The apparatus of claim 1, wherein said plurality of interface cards include a first telecommunications card, a data card, and a second telecommunications card.

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16. The apparatus of claim 15, wherein the first and the second telecommunications cards are SONET cards.

17. The apparatus of claim 15, wherein the data card is at least one Ethernet card.

18. The apparatus of claim 17, wherein the data circuit will be maintained if any or all of the Ethernet cards become inoperable.

19. The apparatus of claim 1, wherein said cross connect unit is passive.

20. The apparatus of claim 1, wherein said cross-connect unit determines when an interface card is inoperable and utilizes the associated matrix to determine where to route the data stream.

21. An apparatus for flexibly routing a data stream around an inoperable interface card, the apparatus comprising:

a plurality of interface cards for transmitting and receiving data streams, wherein each interface card within a set of interface cards are receiving the data stream, the set of interface cards defining a data circuit;

5 a cross-connect unit for routing data streams between the plurality of interface cards;

a control unit for controlling the operation of the apparatus;

10 a backplane for connecting the plurality of interface cards to said cross-connect unit; and

a database containing a matrix for the data circuit that identifies the order that the data stream will be routed to the set of interface cards, for each interface card the matrix includes a destination point and a next destination point,

15 wherein said cross-connect unit utilizes the matrix to determine how to route the data stream, said cross-connect unit automatically routes the data stream to the next destination point when an interface card associated with the destination point becomes inoperable.

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22. An apparatus for flexibly routing a data stream directly from a first interface card to a third interface card, when a second interface card that was supposed to receive the data stream from the first interface card and transmit the data

stream to the third interface card becomes inoperable, the apparatus comprising:

a plurality of interface cards for transmitting and receiving data streams;

5 a cross-connect unit for routing data streams between the plurality of interface cards;

a control unit for controlling the operation of the apparatus;

10 a backplane for connecting the plurality of interface cards to said cross-connect unit; and

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a database containing a matrix that directs where said cross-connect unit routes the data stream, the matrix includes a first destination and a second destination for each interface card, so that when the second interface card fails, the matrix
15 directs said cross-connect unit to route the data stream from the first interface card to the third interface card.

23. A method for maintaining a data circuit in the event that one or more devices within the data circuit become
20 inoperable, the method comprising:

defining the data circuit as a plurality of interface cards that will receive a particular data stream;

generating a matrix based on the data circuit, the matrix including a destination point and a next destination point for
25 each interface card; and

routing the data stream to the appropriate interface cards,
wherein a cross-connect unit routes the data stream to the
destination point identified in the matrix, and if the interface
card associated with the destination point is inoperable to the
5 next destination point identified in the matrix.

24. The method of claim 23, further comprising continually
utilizing the next destination point in the matrix to determine
the next interface card for the cross-connect unit to route the
10 data stream to in event that consecutive interface cards in the
data circuit are inoperable.

25. The method of claim 23, wherein said generating a
matrix includes generating a matrix that includes a destination
15 point, a next destination point, and a previous point for each
interface card.

26. The method of claim 25, further comprising utilizing
the previous point to incorporate an interface card that is
20 defined as part of the data circuit and that was previously
inoperable back into the data circuit when the interface card
becomes operational.

27. The method of claim 23, wherein the data circuit
25 includes SONET cards.

28. The method of claim 23, wherein the data circuit includes Ethernet cards.

5 29. A method for flexibly routing a data stream around an inoperable interface card, the method comprising:

defining a data circuit as a plurality of interface cards receiving the data stream;

utilizing a cross-connect unit to route the data stream
10 between the plurality of interface cards; and

controlling the operation of the cross-connect unit with a matrix, the matrix identifying the order that the data stream will be routed to the data circuit including a destination point and a next destination point for each interface card so that the
15 cross-connect unit automatically routes the data stream to the next destination point when an interface card associated with the destination point becomes inoperable.

30. A method for flexibly transmitting a data stream
20 directly from a first interface card to a third interface card when a second interface card which was planned to receive the data stream from the first interface card and transmit the data stream to the third interface card is rendered inoperable, the method comprising:

generating a matrix that identifies interface cards to receive the data stream, the matrix including destination points and next destination points for each interface card;

receiving the data stream at the first interface card;

5 transmitting the data stream from the first interface card to a cross-connect unit;

determining from the matrix that the cross-connect unit should route the data stream to the second interface card;

determining that the second interface card is inoperable;

10 determining from the matrix that since the second interface card is inoperable the cross-connect unit should route the data stream to the third interface card; and

transmitting the data stream from the cross-connect unit to the third interface card.

15 31. The method of claim 30, wherein the first, the second and the third interface cards are located within a network element.

20 32. A computer program embodied on a computer readable memory for maintaining a data circuit in the event that one or more devices within the data circuit become inoperable, the computer program comprising:

a code segment for defining the data circuit as a plurality
25 of interface cards that will receive a particular data stream;

a code segment for generating a matrix based on the data circuit, the matrix including a destination point and a next destination point for each interface card; and

a code segment for routing the data stream to the
5 appropriate interface cards, wherein the data stream is routed to the destination point identified in the matrix, and if the interface card associated with the destination point is inoperable the data stream is routed to the next destination point identified in the matrix.

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33. The computer program of claim 32, further comprising a code segment for continually utilizing the next destination point in the matrix to determine the next interface card to route the data stream to in event that consecutive interface cards in the
15 data circuit are inoperable.

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34. The method of claim 32, wherein said code segment for generating a matrix generates a matrix that also includes a previous point for each interface card.

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35. The method of claim 34, further comprising a code segment for utilizing the previous point to incorporate an interface card that is defined as part of the data circuit and that was previously inoperable back into the data circuit when
25 the interface card becomes operational.

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36. A computer program embodied on a computer readable memory for flexibly routing a data stream around an inoperable interface card, the computer program comprising:

5 a code segment for defining a data circuit as a plurality of interface cards receiving the data stream;

a code segment for utilizing a cross-connect unit to route the data stream between the plurality of interface cards;

10 a code segment for controlling the operation of the cross-connect unit with a matrix, the matrix identifying the order that the data stream will be routed to the data circuit including a destination point and a next destination point for each interface card so that the cross-connect unit automatically routes the data stream to the next destination point when an interface card
15 associated with the destination point becomes inoperable.

37. A computer program embodied on a computer readable memory for flexibly transmitting a data stream directly from a first interface card to a third interface card when a second
20 interface card which was planned to receive the data stream from the first interface card and transmit the data stream to the third interface card is rendered inoperable, the computer program comprising:

25 a code segment for generating a matrix that identifies interface cards to receive the data stream, the matrix including

destination points and next destination points for each interface card;

a code segment for receiving the data stream at the first interface card;

5 a code segment for transmitting the data stream from the first interface card to a cross-connect unit;

a code segment for determining from the matrix that the cross-connect unit should route the data stream to the second interface card;

10 a code segment for determining that the second interface card is inoperable;

a code segment for determining from the matrix that the cross-connect unit should route the data stream to the third interface card; and

15 a code segment for transmitting the data stream from the cross-connect unit to the third interface card.

20 38. The computer program of claim 37, wherein the first, the second and the third interface cards are located within a network element.

39. An Ethernet switch capable of re-routing a data stream if an Ethernet card within the Ethernet switch becomes inoperable, the Ethernet switch comprising:

a plurality of Ethernet cards for transmitting and receiving data streams;

a cross-connect unit for routing the data streams between said plurality of Ethernet cards; and

5 memory containing a stitching matrix for each port on said cross-connect unit, wherein the stitching matrix identifies a next location to transmit the data stream in the event that a receiving Ethernet card is rendered inoperable.

10 40. In a network element containing multiple interface cards which are interconnected through a cross-connect, a method of seamlessly maintaining connectivity between remaining interface cards, when one or more of said interface cards is disconnected from the cross-connect, the method comprising:

15 defining a circuit mapping table which includes information relating to how said interface cards are connected together through the cross-connect;

detecting when one or more of said interface cards is disconnected from the cross-connect; and

20 connecting the remaining interface cards together through the cross-connect, the connections between the remaining interface cards based on information contained in the circuit table.

41. The method of claim 40, wherein at least a first one of the remaining interface cards was connected to at least a second one of the remaining interface cards through the one or more disconnected cards prior to the one or more interface cards becoming disconnected from the cross-connect.

42. The method of claim 40, wherein said interface cards include one or more Ethernet cards.

43. In a network element containing multiple interface cards which are interconnected through a cross-connect unit, a computer program embodied on a computer readable medium for seamlessly maintaining connectivity between remaining interface cards, when one or more of said interface cards is disconnected from the cross-connect unit, the computer program comprising:

a source code segment for defining a circuit mapping table which includes information relating to how said interface cards are connected together through the cross-connect unit;

a source code segment for detecting when one or more of said interface cards is disconnected from the cross-connect unit; and

a source code segment for connecting the remaining interface cards together through the cross-connect unit, the connections between the remaining interface cards based on information contained in the circuit table.

1.73 43. A method of establishing a virtual intelligent backplane, the method comprising:

connecting a plurality of interface cards to each other through a cross-connect, wherein the manner in which the

5 interface cards are connected defines a data circuit;

establishing a mapping table for the data circuit, the mapping table including direct connections for each interface card and next connections for each interface card;

10 determining that a first interface card that is connected to a second interface card and a third interface card is inoperable; and

connecting the second interface card to the third interface card, when the mapping table defines the third interface card as the next connection for the second interface card.

15 45 44. A computer program embodied on a computer readable medium for establishing a virtual intelligent backplane, the computer program comprising:

20 a source code segment for connecting a plurality of interface cards to each other through a cross-connect, wherein the manner in which the interface cards are connected defines a data circuit;

a source code segment for establishing a mapping table for the data circuit, the mapping table including direct connections

for each interface card and next connections for each interface card;

a source code segment for determining that a first interface card that is connected to a second interface card and a third

5 interface card is inoperable; and

a source code segment for connecting the second interface card to the third interface card, when the mapping table defines the third interface card as the next connection for the second interface card.

10 45. A computer program embodied on a computer readable memory for maintaining a data circuit in the event that one or more devices within the data circuit become inoperable, the computer program comprising:

15 a code segment for defining the data circuit as a plurality of interface cards that will receive a particular data stream;

a code segment for generating a matrix based on the data circuit, the matrix including a destination point and a next destination point for each interface card; and

20 a code segment for routing the data stream to the appropriate interface cards, wherein the data stream is routed to the destination point identified in the matrix, and if the interface card associated with the destination point is inoperable the data stream is routed to the next destination
25 point identified in the matrix.

47 46. An apparatus for maintaining a data circuit in the event that one or more devices within the data circuit become inoperable, the apparatus comprising:

5 means for defining the data circuit as a plurality of interface cards that will receive a particular data stream;

means for generating a matrix based on the data circuit, the matrix including a destination point and a next destination point for each interface card; and

10 means for routing the data stream to the appropriate interface cards, wherein the data stream is routed to the destination point identified in the matrix, and if the interface card associated with the destination point is inoperable the data stream is routed to the next destination point identified in the
15 matrix.

48 47. The apparatus of claim 46, further comprising means for continually utilizing the next destination point in the matrix to determine the next interface card to route the data stream to in
20 event that consecutive interface cards in the data circuit are inoperable.

49 48. The apparatus of claim 46, wherein said means for generating a matrix generates a matrix that also includes a
25 previous point for each interface card.

50 49. The apparatus of claim 48, further comprising means for utilizing the previous point to incorporate an interface card that is defined as part of the data circuit and that was previously inoperable back into the data circuit when the interface card becomes operational.

51 50. An apparatus for flexibly routing a data stream around an inoperable interface card, the apparatus comprising:

10 means for defining a data circuit as a plurality of interface cards receiving the data stream;

means for utilizing a cross-connect unit to route the data stream between the plurality of interface cards; and

15 means for controlling the operation of the cross-connect unit with a matrix, the matrix identifying the order that the data stream will be routed to the data circuit including a destination point and a next destination point for each interface card so that the cross-connect unit automatically routes the data stream to the next destination point when an interface card

20 associated with the destination point becomes inoperable.

52 51. An apparatus for flexibly transmitting a data stream directly from a first interface card to a third interface card when a second interface card which was planned to receive the data stream from the first interface card and transmit the data

stream to the third interface card is rendered inoperable, the apparatus comprising:

means for generating a matrix that identifies interface cards to receive the data stream, the matrix including

5 destination points and next destination points for each interface card;

means for receiving the data stream at the first interface card;

10 means for transmitting the data stream from the first interface card to a cross-connect unit;

means for determining from the matrix that the cross-connect unit should route the data stream to the second interface card;

means for determining that the second interface card is inoperable;

15 means for determining from the matrix that the cross-connect unit should route the data stream to the third interface card; and

means for transmitting the data stream from the cross-connect unit to the third interface card.

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~~§3~~ 52. The apparatus of claim 51, wherein the first, the second and the third interface cards are located within a network element.